Decarbonization and Increased Productivity in the Reheating Furnace Using Hydrogen Fuel




In the last decade, decarbonization of the steel industry has motivated comprehensive investigation on the use of hydrogen fuel in steelmaking. However, the increased heat output of hydrogen-fueled burners also creates opportunities for furnace throughput improvements. The primary factors that affect steel quality and productivity are the uniform distribution of heat, followed by slab residence time in the reheating furnace. Using computational fluid dynamics to model hydrogen utilization and comparing the results to traditional natural gas combustion, opportunities for increased furnace throughput were found due to the higher relative heat output of hydrogen as a fuel. One approach covered in this study is the use of regenerative burners in a reheating furnace using hydrogen as fuel. Apart from the decarbonization achieved while using hydrogen as fuel, the additional effect of using regenerative burners in such a furnace is studied with respect to thermal efficiency and productivity increase.

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In a reheating furnace, steel slabs are heated to a temperature of about 1,500 K before being delivered to the rolling machine for further milling. The reheat furnace is one of the most crucial processes in steel production that impacts product quality, and it also consumes the second-highest amount of energy. The three zones that make up a typical reheat furnace — the pre-heat zone, the heat zone and the soak zone — each play a specific function in the correct heating and temperature dispersion into the slabs. The slab is slowly heated with a low temperature gradient in the pre-heat zone to prevent deformations, and then it is correctly heated to the desired temperature in the heating zone before entering the soak zone, where the temperature is dispersed uniformly throughout the slab.

For any steel mill, efficient operations, high-quality products and harmful emission control are significant aims. Ongoing efforts are made to enhance product quality, cut costs and preserve the environment. To significantly lower the enormous energy consumption and improve the operation of a reheating furnace while controlling emissions, much care must be taken. Its thermal efficiency is intimately tied to environmental concerns because cutting back on energy use immediately lowers carbon dioxide emissions and maybe NOx, which are major greenhouse gases.

For this study, the thermal modeling of the furnace plays a critical part. Different computational fluid dynamics (CFD) techniques have been applied to simulate the heating process of such a reheating furnace. Most of these numerical techniques are either too simplified or computationally expensive. Ahmed claims to have used a novel time-efficient numerical technique to model large industrial-sized furnaces accurately.[1] A transient approach to modeling the dwell time of the slab is more accurate than a steady-state approach. Han et al. carried out a transient numerical analysis of slab heating in a reheating furnace using ANSYS FLUENT with the help of a user-defined function (UDF). The simulation was iterative until the change in temperature was minimal then the simulation was considered converged, and the slab was considered to be ready for the strip mill. The simulation included skids and